mai 2008

agrimonde

Edito

Why a CIRAD-INRA Foresight Study on World Food and Agricultural Systems in 2050?

Recent food riots brought home the crucial importance of food and agriculture in dramatic fashion. They are one of this century's major concerns. Beyond the current crisis, world agriculture must address three challenges: demographic growth - we will be 9 billion people in 2050 - and food security in both quantity and quality; protection of the environment and natural resources; and the growing scarcity of fossil fuels. In this perspective, we decided in early 2006 to take the initiative of developing a capacity to analyse the possible balances of global food and agricultural systems in 2050. This document summarises some of the results of this «Agrimonde» foresight study. We have a twofold objective: to provide our two institutions, and more generally our country, with a basis for discussion of global food and agriculture issues, and to identify the top priority research questions submitted to CIRAD and INRA and to international agricultural research as a whole. The challenge of food forces us to understand and plan ahead, and to carry out research through debated priorities.

Marion Guillou
Chair and CEO of INRA

Patrice Debré
Chair, CIRAD Board of Trustees

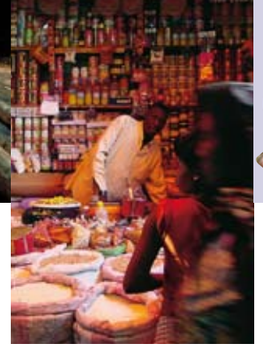
Key figures

Between 1961 and 2003, the world's population increased from 3.1 to 6.3 billion.

At the same time:

- Average food supply increased from 2,500 to 3,000 kcal/day/person. It remains very unevenly distributed, ranging from 2,400 in Sub-Saharan Africa to 4,000 in OECD countries; 850 million human beings remain undernourished;
- Cultivated surfaces increased by 13% and irrigated land doubled; as of 2003, 1.5 billion hectares were cultivated and 18% of these surfaces were irrigated;
- The cultivated surface needed to feed one person has been halved (from 0.45 to 0.25 per capita);
- There has been intensification by hectare, with a world average vegetal food production per hectare more than doubling from 8,600 to 19,200 kcal/day/ha. Even though this trend is throughout the planet at relatively comparable proportions, yield gaps between regions have increased - from 1 to 2 in 1961, they are now at 1 to 3.4 today.








Interview with Michel Petit, member of the «Agrimonde» foresight study working group

The Agrimonde project is interesting for two major and closely-related reasons. It combines a quantitative with a qualitative approach, and it is the fruit of true collaboration between a permanent project team and a working group made up of experts with different skills, backgrounds, and disciplines.
As a member of the working group and with several years of international experience under my belt, primarily with the Ford Foundation in India and more than ten years at the World Bank, I am taking the liberty of judging the originality of the approach and the range of its initial results.

The principle of the Agrimonde quantitative module is simple. It consists of drawing up resource-use reports by global region, expressed in vegetal food calories, with an innovative data processing for simulating the conversion of vegetal food calories into animal ones. The quasi-totality of food products is taken into account and geographic coverage is exhaustive, already an original point in itself compared with approaches that target specific productions. In doing so, we were able to reveal past global phenomena that were at times very little understood, such as relative intensification of African agriculture over the past four decades.

Meanwhile, the qualitative component puts forward assumptions and analyses their implications. For instance, an average consumption of 3,000 kilocalories per person per day in all regions of the world by 2050, with 15% from animal products, would require a radical rethinking of past trends in this area. >>>

Objectives and method

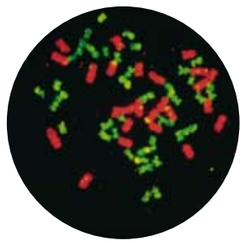
A collective discussion tool on global food and agriculture issues

Agrimonde, a joint initiative between INRA and CIRAD under the aegis of their common structure (GIP IFRAI), is a collective instrument for the discussion of global food and agricultural issues that can be summed up as follows: feeding 9 billion people in 2050 while preserving the ecosystems from which other products and services are also expected - carbon storage, biodiversity, bioenergies, biomaterials, etc. The study also strives to prepare for the fundamental questions that agricultural research will face in coming years. Through this initiative, the two institutes are shaping the means to contribute to international debate on food and agriculture issues on one hand, and to prepare the ground for future research paths on the other hand.
Many stakeholders and factors come into play in this complex issue, be they agricultural, ecological, technical, economic, sociological, cultural or geopolitical. Moreover, the global scale at which the discussion should be conducted does not preclude regional analyses, given that the diversity of diets and agricultural production systems, and their interactions though trade, are key parameters for the future.
Agrimonde is a simple tool that can be easily adopted by the different stakeholders. It combines a quantitative approach with a qualitative analysis in a complementary and interactive manner. The quantitative approach is based on a model of physical equilibrium between food production and its uses, including non-food ones, both expressed in calorie equivalents. Meanwhile, the qualitative analysis uses the quantitative study of past trends as a springboard to define regional scenarios for 2050 and break them down in terms of changes in population levels, diets, non-food use of agricultural products, cultivated areas, yields, etc. The quantitative module is then used to calculate the balance between biomass resources and uses in each region and by aggregation, at the global scale. Such a method makes it possible to discuss, verify and, if necessary, rethink the assumptions of a given scenario. It also makes it possible to reflect on the consequences of the latter and its underlying assumptions, in a global perspective that takes into account numerous dimensions of food and agriculture issues and their interactions.
The scenarios of the Millennium Ecosystem Assessment (MEA) are now a reference point, not only for global environmental problems, but also for issues touching on agriculture and development. Quite naturally, then, Agrimonde began with an analysis of the consequences of these scenarios in terms of agricultural and food systems. It then continued with the definition of a breakaway scenario - Agrimonde 1 - that presupposes a radical parting of ways from past food consumption trends, and the satisfactory contribution of agriculture to global sustainable development.
The goal is to assess the likelihood of such a scenario. It does not seek to create an ideal scenario, but rather, to test the concept of sustainable development and the role that may be played by food and agriculture in identifying the actions needed to achieve it, and to explore the predicaments that are revealed.

Agrimonde combines a quantitative approach with a qualitative analysis in a complementary and interactive manner

>>> Interview with Michel Petit (part II)
Likewise, assuming that the amount of agricultural land could increase in the future would require analysis of the investments needed for this purpose and of the environmental impact. Moreover, running qualitative hypotheses through the quantitative module raises questions about the future, and even leads to recasting these issues.

The most interesting aspects are yet to come. The quantitative results obtained must be consolidated to shore up the validity of initial conclusions, already highly instructive in themselves. At the same time, a long-term yet flexible institutional instrument should be established to develop dialogue with the many partners interested in the approach, its results and the conclusions to be drawn for research, public and private stakeholders.



Glossary

Apparent food supply: ratio between the calorie equivalent of available foodstuff (production + imports - exports +/- stock variations) for feeding the inhabitants of a region (i.e., excluding animal feed, non-food use, seed and post-harvest losses), and the number of inhabitants in that region. The numerator includes losses between the supply to households or communities and the true amount ingested.

FAO: Food and Agriculture Organization of the United Nations.

IAASTD: International Assessment of Agricultural Knowledge, Science and Technology for Development (group of experts on agriculture created at the instigation of the United Nations and the World Bank, and which mobilised over 900 experts in 110 countries from 2004 to 2007).

IFRAI: French Initiative for International Agricultural Research (created by CIRAD and INRA in 2007).

MEA: Millennium Ecosystem Assessment (international group of experts on ecosystems created at the initiative of the United Nations. It mobilised over 2000 experts in 95 countries from 2001 to 2005).

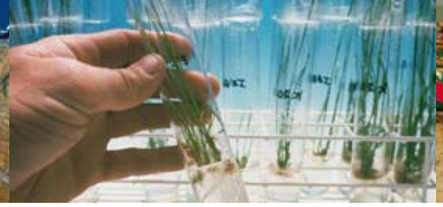
OECD: Organization for Economic Cooperation and Development.

Agrimonde relies on:

. A project team comprising CIRAD and INRA scientists, Maryse Aoudaï (INRA), Jean-Marc Chaumet (INRA), Bruno Dorin (CIRAD, responsible for quantitative modelling and analysis), Tristan Le Cotty (CIRAD), Sandrine Paillard (INRA, responsible for Foresight Study), Tévécia Ronzon (INRA) and Sébastien Treyer (AgroParisTech-Engref, responsible for analysis of scenarios and their consequences), coordinated by Bernard Hubert (IFRAI);

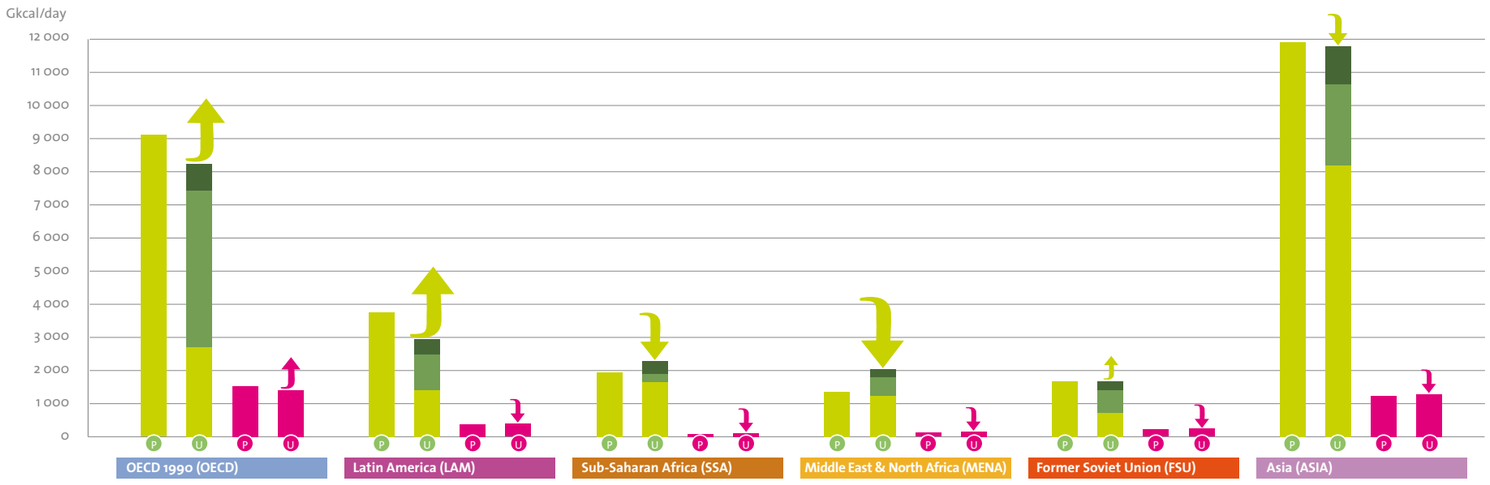
. A working group made up of experts with different skills, backgrounds and disciplines (definition of scenarios, methodology assistance and analysis of results): Bernard Bachelier, Danielle Barret, Pierre-Marie Bosc, Jean-Pierre Butault, Jean-Christophe Debar, Marie de Lattre-Gasquet, Gérard Ghersi, Francis Delpeuch, Fabrice Dreyfus, Michel Griffon, Christian Hoste, Denis Lacroix, Jacques Loyat, Michel Petit and Jean-Louis Rastoin;

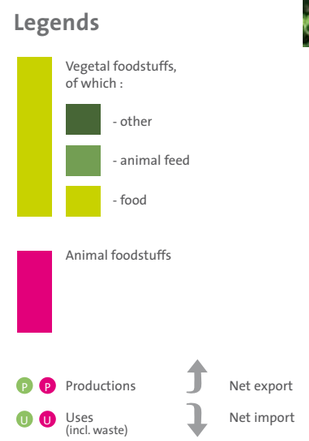
. A committee of experts representing some twenty institutions (discussion of results and their consequences, general orientation of research).

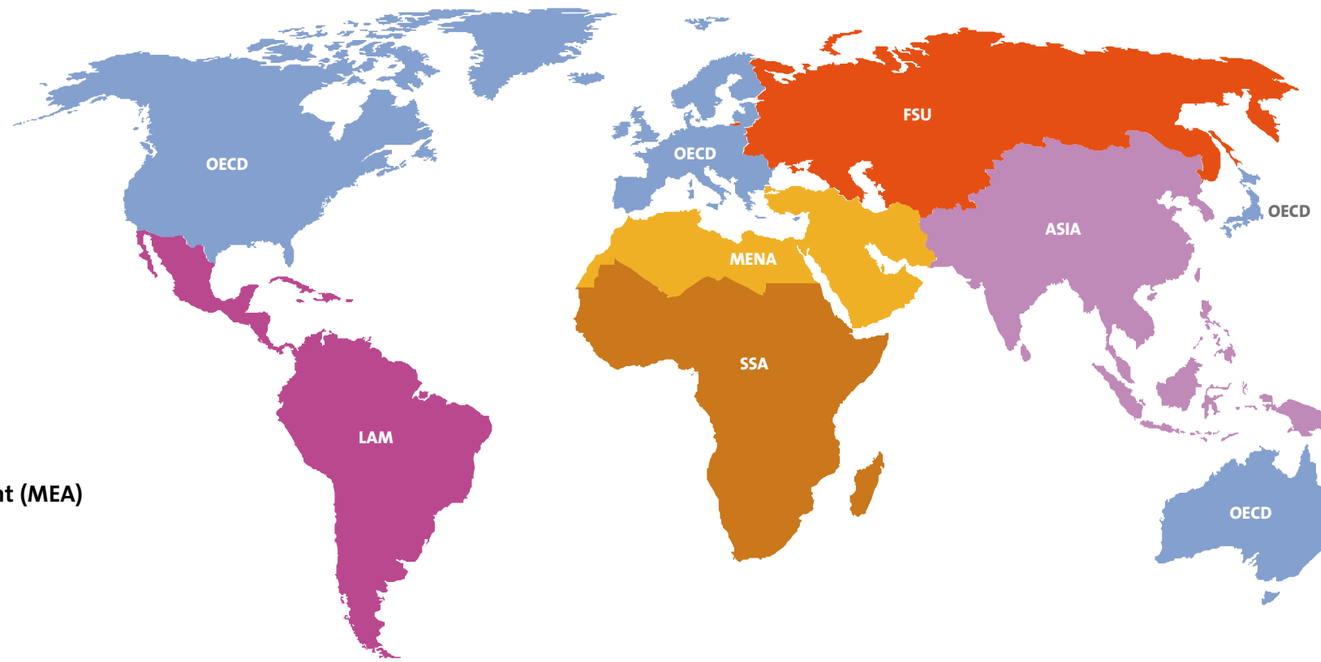


Food Resources, Production, Trade and Uses in 2003 for six major world regions

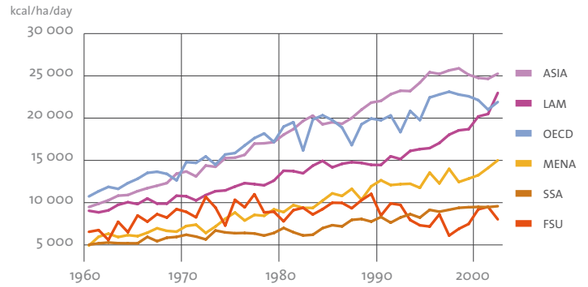
Source: B. Dorin/CIRAD, based on FAO data







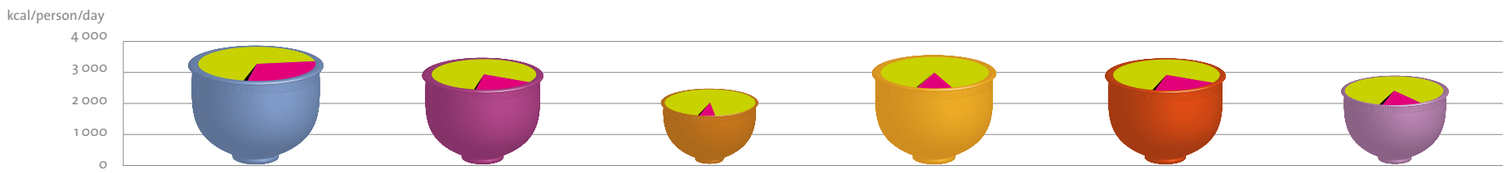
Plant food production per hectare of cultivated land (1961–2003)



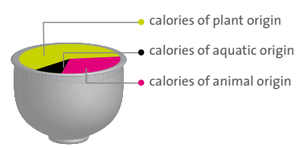
Regions of the Millennium Ecosystem Assessment (MEA)

- **OECD** Organization for Economic Cooperation and Development
- **LAM** Latin America
- **SSA** Sub-Saharan Africa
- **MENA** Middle East & North Africa
- **FSU** Former Soviet Union
- **ASIA** Asia

OECD	LAM	SSA	MENA	FSU	ASIA
25% of forests (981 Mha)	23% of forests (922 Mha)	16% of forests (634 Mha)	1% of forests (35 Mha)	21% of forests (843 Mha)	13% of forests (533 Mha)
22% of pastures (736 Mha)	16% of pastures (553 Mha)	24% of pastures (827 Mha)	10% of pastures (337 Mha)	11% of pastures (360 Mha)	17% of pastures (565 Mha)
27% of cultivated land (416 Mha)	11% of cultivated land (164 Mha)	13% of cultivated land (204 Mha)	6% of cultivated land (90 Mha)	13% of cultivated land (202 Mha)	30% of cultivated land (462 Mha)
23% of arable lands (900 Mha)	25% of arable lands (984 Mha)	26% of arable lands (1054 Mha)	2% of arable lands (92 Mha)	10% of arable lands (409 Mha)	14% of arable lands (538 Mha)
2% of farmers (22 M)	3% of farmers (43 M)	15% of farmers (195 M)	3% of farmers (44 M)	1% of farmers (20 M)	76% of farmers (1014 M)
16% of the population (987 M)	9% of the population (538 M)	11% of the population (714 M)	6% of the population (400 M)	4% of the population (279 M)	53% of the population (3330 M)



OECD	LAM	SSA	MENA	FSU	ASIA
3 955 kcal/person/day available incl. 125 g of proteins and 165 g of fats	**3 142 kcal/person/day available incl. 94 g of proteins and 90 g of fats**	**2 366 kcal/person/day available incl. 60 g of proteins and 48 g of fats**	**3 356 kcal/person/day available incl. 105 g of proteins and 79 g of fats**	**3 276 kcal/person/day available incl. 106 g of proteins and 89 g of fats**	**2 793 kcal/person/day available incl. 78 g of proteins and 73 g of fats**



The Agrimonde 1 scenario

Basic principles

The Agrimonde 1 scenario obeys the following basic principles:

• The scenario places food and agriculture in the context of sustainable development in its usual economic, environmental and social dimensions, as well as aspects touching on the relationship between food and health;

• Its goal is to assess the capacity of each major world region to meet its food and nutritional needs by 2050 in order, in the one hand, to focus discussion on the actions required for this purpose, and, on the other hand, to identify the areas that would not be self-sufficient and, as a result, are likely to resort to importing. The scenario considers the movements of food and agriculture from oversupplied to undersupplied regions;

• The hypothesis of large migratory waves between zones is set aside in order to become fully cognizant of the consequences of the expected strong demographic growth in Africa, Asia and Latin America. Population changes in the different regions by 2050 thus correspond to median United Nations projections in a so-called normal regime of international migrations, that is, 100 million migrants over 50 years.

• Owing to the lack of precise numbers estimating the consequences of climate change on global agriculture, such consequences are not including in the quantitative evaluation in the strict sense. Nevertheless, they are taken into account during qualitative analysis.

The two variants o f the scenario

Agrimonde 1 is enacted in two variants.

In the first, by 2050, the planet's 9 billion inhabitants will have on average 3,500 kcal/day/person in each major region. A significant portion of this will come from animal goods. To meet these needs, large-scale increases in cultivated surfaces and agricultural yields will be needed in all regions of the world, including Asia, the OECD countries, and Latin America, although productivity by hectare is already high in these areas. Global food balance can be achieved by making strides in yields to the extent described in MEA scenarios; this is not the case for farmland that must expand in much higher proportions.
Such increases would require the cultivation of still-unused land reserves, especially in Sub-Saharan Africa and Latin America. This implies the conversion of pasture or forest to farmland, with potentially negative consequences on ecosystems. In sum, this first variant of the Agrimonde 1 scenario highlights the need for strong action in environmental protection, more specifically in terms of limiting greenhouse gas emissions and preserving biodiversity.

The second variant assumes that diets will converge in 2050 in each major region to reach a mean of much lower apparent supply, that is, 3,000 kcal/day/person, 15% of which come from animal origin. This scenario represents a major shift that, moreover, varies according to region. Average calorie supply would increase significantly in Sub-Saharan Africa, while it would markedly decrease in OECD countries, in part owing to reduced losses. Moreover, the proportion of animal products in food rations would increase in Sub-Saharan Africa and decrease in the OECD nations.

On the basis of relatively moderate growth in cultivated land, the global food balance would rely on modest - if any - yield improvements, except in Sub-Saharan Africa and in the former Soviet Union.

Results

Regardless of the Agrimonde 1 scenario variant taken, it appears that feeding the planet sustainably in 2050 is possible.

Nevertheless, this requires:

. A major shift in food consumption trends, more specifically a break in the relationship that associates higher revenues with higher consumption;

. Large investments in infrastructures, research and development, not only to increase yields per se, but to develop and spread agricultural production systems that are compatible with the preservation of ecosystems and can resist climate change;

. Proactive policies at different organisational levels, from local to global, in order to make structural developments in agricultural systems and consumption modes possible, on one hand, and, on the other hand, to organise and regulate trade of agriculture and food between regions;

. Reducing losses at all levels (agriculture, storage, transport, processing and distribution, consumption).

• The first variant, at 3,500 kcal/day/person, places the emphasis on production efforts that are needed to cover a high level of caloric availability by 2050, a significant part of which coming from animal products. The question varies from region to region. In Asia, where land reserves are limited and yields already high, further intensification should be pursued while reducing environmental impacts. In Sub-Saharan Africa, gains could be realised from both still-unused land reserves and improved yields, and these two sources of progress should be managed sustainably. In North Africa and the Middle East, the potential for production growth will be limited by water availability.

• The second variant, at 3,000 kcal/day/person, brings up for discussion the different modes of production and consumption, as well as the measures needed to keep losses to a minimum, that is, to narrow the gap between agricultural production and the true quantities consumed. In this variant, priorities also vary by region (reducing losses during storage and transport in developing countries, and during processing and consumption in and outside the home in industrialised nations).

The Agrimonde 1 scenario

Lessons and challenges

The Agrimonde 1 scenario shows that some room for manoeuvre exists for meeting the planet's food needs in 2050 in a sustainable manner. Taking advantage of this leeway will require substantial efforts, and more specifically, the development of research on the following:

• The required increases in cultivated land and yields demonstrate the need to explore and exhaust all possibilities for ecological intensification of agricultural systems as well as to identify the needs in terms of research, innovation, training, collective organisations and public policies required to achieve this purpose.

• The traditional boundaries between town and country, agriculture and forest, and agricultural production and environmental preservation are being called into question in several, if not all, regions. Should these boundaries be reinforced, for example through the juxtaposition of ecological corridors and zones of intensive agricultural production? Or, on the contrary, would it be more appropriate to make such boundaries more permeable by encouraging the development of urban and peri-urban agriculture, agroforestry, agroecology, etc.?

• Local and scientific know-how should be jointly mobilised to encourage the dynamics of ecological intensification. How can such know-how be combined or spread?

• In the Agrimonde first foresight exercise, a major asset is patently the diversity and specificities of diets, of regional historical, cultural and sociological paths, of ecosystems, of production, processing and distribution channels. How then should the strategies of stakeholders - from small farmers to multinational food companies, from non-governmental organisations to public decision-makers - be bolstered to ensure the harmonious, long-term coexistence of this diversity at different levels?

• Innovation quite naturally presupposes progress in knowledge, but also strong and coherent public policies that specifically take the multiple challenges into account. In particular, there is a need to implement policies that can guarantee:

- Investments, development of infrastructures, organization of vertical channels of production, land management and territorial development;
- Regulation of exchanges to ensure the food security of regions that cannot fully cover the basic needs of their populations;
- A shift in individual consumption and loss-minimisation behaviour.

Next steps

Improving the tool and submitting the first results to a wide audience for discussion will make it possible to formulate new assumptions and to design alternative foresight scenarios. Through the exploration of possible futures, without preconceptions, Agrimonde will fulfil its original ambitions, i.e. to provide the two institutes with the capacity to participate fully in international debate on the sustainability of food and agricultural systems in 2050 and to identify priority research areas.

INRA CIRAD

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mai 2008

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Graphic design and layout: NovaTerra/Denis Delebecque-Delphine Bonnet. **Credits:** cover illustr.: Faire Savoir.
Map illustr.: NovaTerra/Chloé Sarda. Photos: Photothèques INRA and CIRAD. **www.inra.fr** **wwww.cirad.fr**